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1988-89 SURVEY OF PHYSICS AND ASTRONOMY BACHELOR'S DEGREE RECIPIENTS

When all the requirements for a physics or astronomy bachelor's degree are completed, it is time for these graduates to re-evaluate their career goals. For over thirty years, a majority of this group of new bachelors has chosen graduate study rather than immediate employment. While most of them continued their physics studies, the switching of disciplines upon entering graduate school has always been an attractive option for a significant proportion of each graduating class.

This report provides a detailed look at the different postbaccalaureate plans of approximately 2900 new physics and 150 new astronomy bachelors of the class of 1989. All the information comes directly from the degree recipients whom we contact individually and whose current information we compare with that of earlier years to reveal trends when significant changes occurred. Highlights of the information presented in this report are:

- ➔ The number of women among the physics bachelors almost tripled in fifteen years.
- ➔ The highest median starting salary, in 1989, was paid to women by the manufacturing industry.
- ➔ Approximately 12% of the physics bachelors transferred from junior colleges.

The group, among the physics bachelors, often singled out for special attention, is the one we refer to as "potential physicists"; their plan is to enter physics graduate programs without interruption. The size of this group, in the class of 1989, (when scaled up) was an estimated 1560

Table I. Postbaccalaureate plans of selected graduating classes of physics bachelors, 1973-1989.

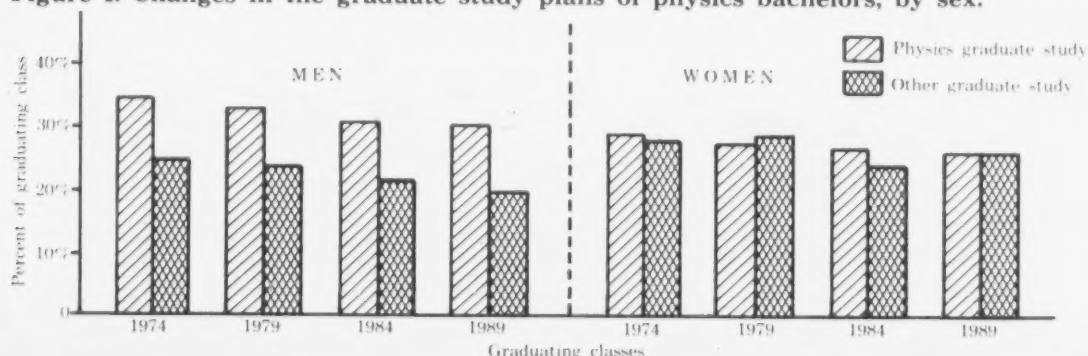
Postbaccalaureate plans	1973-74	1978-79	1983-84	1988-89
Physics graduate study	34%	31%	30%	30%
Other graduate study	25	24	22	21
Civilian employment	36	38	40	41
Military service	4	5	6	6
Undecided	1	2	2	2
Total number of physics bachelor's degrees	4652	4416	4878	5226
% women included *	7%	11%	14%	16%

*The percentage of women was adjusted for the differential response rates between the Survey of Bachelor's Degree Recipients and the Survey of Enrollments and Degrees.

bachelors, a total very close to the one recorded fifteen years earlier. During the interim period this group temporarily declined to 1300 graduates per year. **Table I** lists the postbaccalaureate plans of graduates at five-year intervals and focuses on the changes that occurred since 1973-74. The lower portion of this table indicates the total number of degree recipients involved and the percentage of women in each of those graduating classes.

As the percentage of women per graduating class rose from 7% to 16%, their numbers almost tripled in fifteen years; consequently a comparison between their postbaccalaureate plans and those of their male cohorts appeared to justify a closer examination. In order to highlight persistent differences, **Figure I** focuses on the two groups of bachelors who chose graduate studies. Although "other graduate study" includes only a few disciplines that are

Figure I. Changes in the graduate study plans of physics bachelors, by sex.



significantly different from physics, a larger proportion of the women graduates, than their male counterparts, each year, refer to their impending graduate studies as nonphysics subjects. The most frequently chosen discipline by women or men is engineering, but the areas of graduate study that attract a larger proportion of women than men are biophysics and the life sciences (10% versus 3%), education (10% versus 3%) and the earth sciences (8% versus 4%).

Whenever we add a new question to our survey form we tend to be somewhat apprehensive about the findings until

we are able to confirm them by surveying a second group of graduates. The new question asked for the second time deals with 'when do physicists develop their interest in that science'? The first characteristic in **Table II** summarizes the answers to this question in terms of four time periods and shows that irrespective of the graduate's post-degree plan, the senior high schools spark that interest in physics in a majority of the bachelors. Other characteristics presented in **Table II** indicate the increase in the proportion of women and a small shift from public to private institutions among bachelors with graduate school plans. Physics bachelors who transferred from junior colleges continue to comprise approximately 12%.

Table II. Characteristics of new physics bachelors, 1988-89.

Characteristics		Postbaccalaureate plans				Total
		Graduate study		Employment	Undecided	
		Physics	Other			
Initial interest in physics	{ Jr. high school or earlier	23%	16%	17%	22%	19%
	{ High school	54	57	55	54	55
	{ College	22	26	25	20	24
	{ Other	1	1	3	4	2
Sex	{ Female*	15%	20%	16%	24%	16%
	{ Male	85	80	84	76	84
Citizenship	{ U.S.	90%	92%	96%	97%	93%
	{ Foreign	10	8	4	3	7
Age	{ 21 or younger	8%	5%	2%	6%	4%
	{ 22	44	44	30	37	38
	{ 23	22	27	24	16	23
	{ 24-27	16	17	27	27	22
	{ 28 or older	10	7	17	14	13
Minority groups	{ U.S. blacks	2%	2%	3%	4%	3%**
	{ U.S. Hispanics	2	1	2	-	2
	{ U.S. Asians	5	5	4	7	5
	{ Foreign minorities	6	7	2	3	4
Transferred from junior college	{ Yes	10%	10%	16%	14%	12%
	{ No	90	90	84	86	88
Type of undergraduate institution	{ Public	52%	48%	64%	63%	59%**
	{ Private	48	52	36	37	41
	{ PhD-granting	60%	47%	47%	47%	48%**
	{ MS-granting	10	10	11	9	11
	{ BS/BA-granting	30	43	42	44	41
Total number of bachelors		1558	1099	2441	128	5226**
% distribution		30%	21%	47%	2%	100%
Number of respondents		856	604	1342	70	2872

*Percentage of women was adjusted for differential response rate.

**Data derived from the Survey of Enrollments and Degrees.

Table III. A comparison of the high school physics backgrounds between 1988-89 physics bachelors from public and private institutions.

Type of high school physics	Undergraduate institution		Total	
	Public	Private	N	%
PSSC*	5%	7%	160	6%
Project physics	2	2	61	2
AP physics	14	22	484	17
General physics	61	63	1728	62
None	18	6	364	13
Total respondents	% N	100% 1588	100% 1209	100% 2797

*PSSC = Physical Science Study Committee.

Having credited the high schools with sparking that first interest in physics in a majority of the physics bachelors, we examined the types of physics courses our survey respondents had enrolled in. Table III lists several types of high school physics courses and compares the graduates from private, with those from public undergraduate institutions. For example, the graduates from private institutions include a much larger proportion of students, 22%, who took AP physics than the 14% recorded for the graduates from public institutions. Another significant difference is that only 6% of the graduates from private institutions, compared with 18% of the public college graduates, did not take physics in high school at all.

Although the four major minority groups are included in Table II, its format tends to obscure the differences in the distributions of their postbaccalaureate plans. By viewing each minority group's plans separately, Table IV can show clearly how the career goals of U.S. blacks are skewed toward employment and thereby differ substantially from

Table IV. Postbaccalaureate plans of U.S. and foreign minorities among the responding physics bachelors of the class of 1989.

Minorities	Postbaccalaureate plans			Total	
	Graduate study			% N	N
	Physics	Other	Empl.		
U.S. blacks	20%	20%	60%	100%	64
U.S. Hispanics	33	15	52	100	49
U.S. Asians	33	22	45	100	135
Foreign minorities	43%	31%	26%	100%	127
All respondents	30%	21%	49%	100%	2872

the postbaccalaureate plans of other U.S. minorities. Foreign nationals, by and large, are in the United States on student visas which make them ineligible for regular employment; hence 74% of them choose graduate studies upon receiving their bachelor's degrees.

Four background characteristics of physics bachelors, who identified themselves with one of five distinct minority groups, are listed in Table V. The larger groups, presented in this table, are divided on the basis of citizenship, thereby reflecting increases among the foreign Orientals as well as the group of other foreign Asians. A comparison of the characteristics with those reported in the previous year reveal two changes among U.S. Orientals: (1) the respondents from the class of 1989 include a greater proportion of women, and (2) geographically, the graduates of this minority group are more evenly distributed; instead of a majority graduating from institutions in the Pacific region, an increasing number of them graduated from institutions in the Northeast.

Table V. Selected characteristics of minority physics bachelors, 1989.

		Minority group								
		Black		Native American Indian	Hispanic		Oriental		Other Asian	
		U.S.	Foreign		U.S.	Foreign	U.S.	Foreign	U.S.	Foreign
Total		64	11	5	49	5	100	69	35	42
Sex	Female	12	-	1	10	1	18	17	3	5
	Male	52	11	4	39	4	82	52	32	37
Age	21 or younger	1	-	-	3	-	9	5	6	7
	22	11	-	1	9	1	31	16	13	8
	23	23	-	-	10	-	16	17	8	3
	24	9	3	1	6	2	18	11	3	8
	25-27	12	2	1	13	2	14	12	3	5
	28 or older	8	6	2	8	-	12	8	2	11
Region* of bach's inst.	Northeast	10	2	1	5	2	32	16	9	9
	Southeast	33	7	-	5	1	11	9	8	4
	Central & Mountain	18	2	3	21	1	18	22	9	19
	Pacific	3	-	1	18	1	39	22	9	10
Type of bach's inst.	PhD-granting	14	4	2	25	2	67	39	20	23
	MS-granting	8	1	1	8	-	6	5	5	5
	BS/BA-granting	42	6	2	16	3	27	25	10	14
	Public	35	6	4	36	1	54	39	17	28
	Private	29	5	1	13	4	46	30	18	14

*Regions: Northeast = New England, Middle Atlantic; Southeast = South Atlantic, East South Central; Central = East North Central, West North Central, West South Central.

Table VI. Sources of anticipated support for first-year graduate study*, 1987-89.

Table 1. Sources of anticipated support for next year's graduate study, 1987-89							
Sources of support	Students planning:						
	Physics graduate study			Other graduate study			
	1987	1988	1989	1987	1988	1989	
Teaching assistantship	52%	51%	50%	16%	15%	17%	
Research assistantship	12	11	9	15	20	17	
Fellowship	12	14	16	18	12	18	
Family, savings, loan	5	4	5	23	23	21	
Part-time employment	2	4	4	10	15	13	
Other	3	1	4	5	2	5	
Multiple {	TA/RA	8	6	5	5	5	4
	TA/Fellowship	4	6	5	1	3	3
	TA/Family, savings, loan						
		2	3	2	7	5	2
	100%	100%	100%	100%	100%	100%	
Graduate study status {	full-time	92%	91%	93%	81%	85%	84%
	part-time	8	9	7	19	15	16
Total number of full-time students	1545	1525	1558	1132	1077	1099	

*The information was reported for September of each academic year.

For over two decades differences in the sources of support available for first-year graduate students have been closely related to the subjects of study; **Table VI** illustrates this observation for the late 1980s. Assistantships support a majority of the graduate physics students but only one-third of those entering "other graduate study." But more importantly, by choosing physics, only a small proportion of the graduate students need to resort to family savings, loans or part-time off-campus employment, in contrast to the 33% to 38% of the nonphysics graduate students whose major support consists of those categories.

One source of support conspicuously omitted from the listing in **Table VI** is full-time employment. Each year, approximately 300 physics bachelors who had accepted full-time employment pursued graduate studies on a part-time basis and are presented only in the lower portion of **Table VI**.

It would be wrong to assume that the employment-oriented physics bachelors ignore altogether the graduate study necessary to become a physicist. In answer to a question concerning their future plans for graduate study in physics, 20% of that group perceived their employment as a one-year interruption in their studies and over half of that group were less precise about whether they will resume their study of physics, but expressed a desire to do so at

some future date. Approximately 25% specified "no interest in graduate studies as long as their employment remains challenging."

Since so large a proportion of the physics bachelors choose immediate employment each year, an analysis of the demand for them has become an important part of this survey. To accomplish that we asked each employment-oriented bachelor for the number of job offers he or she received, which provides us with a scale of no offers, one offer, and multiple offers. **Table VII** presents these data consecutively for the most recent five years and adds 1980 and 1975 for comparison purposes. The first category "zero job offers" may require some clarification so as not to mistake it for a general unemployment rate; it refers to the time immediately after graduation when many bachelors have allotted insufficient time to explore the job market. **Table VII** shows no change from the previous year but indicates a lower demand than that recorded in 1980 and 1985 because only 16% of the 1989 graduates reported multiple job offers to choose from.

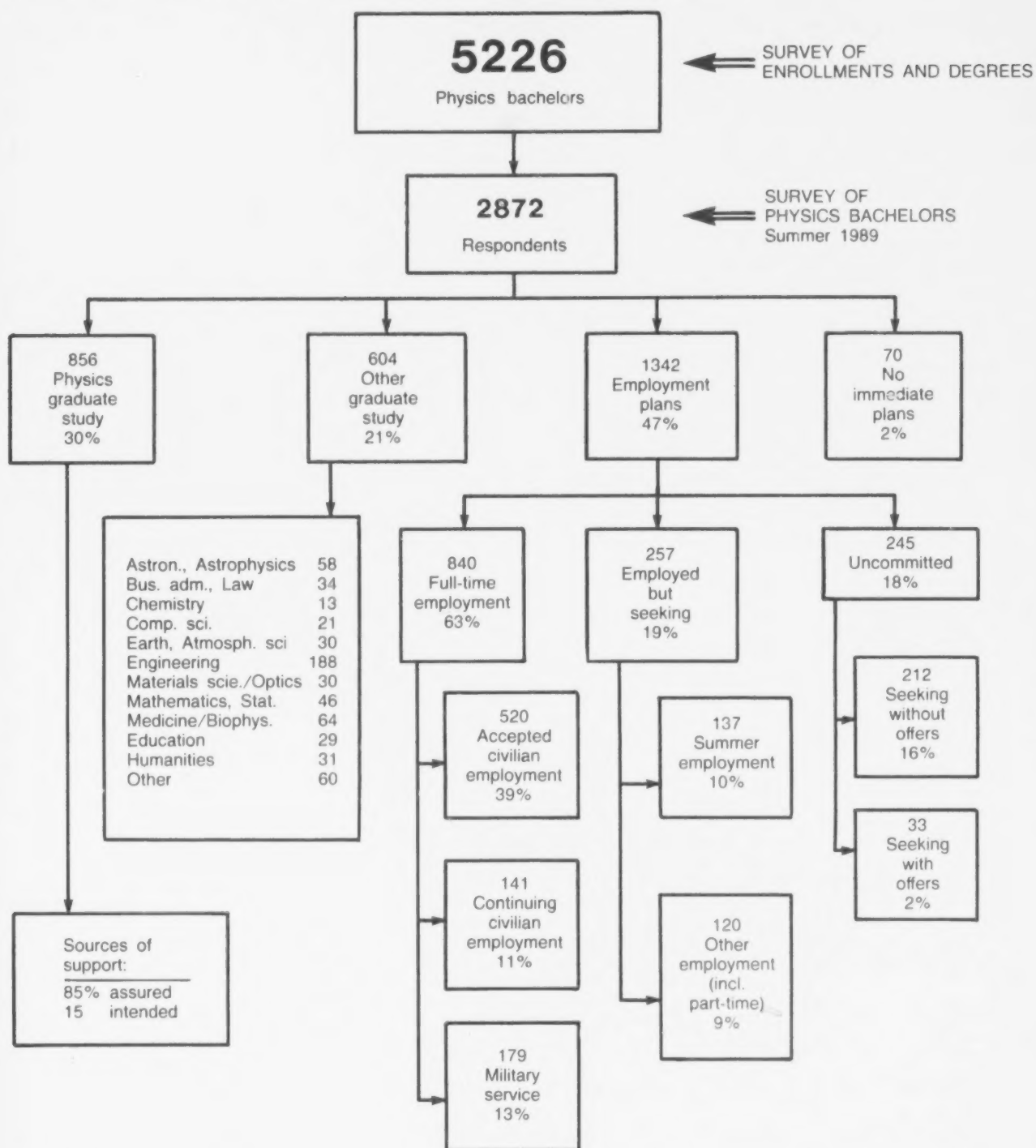
Figure II elaborates on the postbaccalaureate plans of the three major groups of physics bachelors by showing that most of the potential graduate students were "assured" of their sources of graduate school support, by listing the major subjects of "other graduate study" and by offering considerable detail on the employment plans. In view of its

Table VII. Changes in employment outlook for new physics bachelors, 1975-1989.

Number of job offers at graduation	Summer 1975	Summer 1980	Summer 1985	Summer 1986	Summer 1987	Summer 1988	Summer 1989
0	17%	10%	14%	13%	15%	16%	16%
1*	56	50	59	66	68	67	68
2 or more	27	40	27	21	17	17	16

*Bachelors who enter the military are included here.

Figure II. Postbaccalaureate plans of physics bachelors of the class of 1989.



size, the large employment-oriented group of graduates needs to be subdivided and a suitable basis is one that measures how firm the commitments are. Thus we find that two-thirds of this group were in stable full-time employment which they had secured either before (referring to those who continue their employment) or after

graduation. The second group, though employed, indicated that their positions lacked either a permanent or a full-time status; consequently these bachelors described themselves as "employed and seeking." The members of the remaining group were still actively seeking suitable employment when they responded to this survey.

Table VIII. Initial employment of physics bachelors, 1979-89.

Type of employer	Percentage of employed bachelors									
	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89
Industry { manufacture	41%	40%	38%	33%	38%	35%	30%	28%	28%	25%
{ service	20	22	22	20	16	20	18	18	25	24
High school	3	2	3	4	4	4	7	6	5	5
College or university	3	4	4	4	5	3	4	4	4	5
Government { civilian	8	7	7	10	12	14	13	11	9	12
{ military	16	21	24	27	24	23	28	32	28	27
Other	9	4	2	2	1	1	-	1	1	2
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

One approach to satisfy the requests for projecting the demand for physics graduates, is to provide the trend data necessary to make those projections. Thus we list in **Table VIII** the types of employers, for the decade of the 1980s, who filled their entry-level positions with new physics bachelors. Although industry remains the largest employer of physics bachelors, a conspicuous trend evident from this table is the steady decline of industrial manufacturing jobs. For example, in 1980 the graduates filled twice as many manufacturing as service industrial positions; by the end of the 1980s this 2:1 ratio changed to a 1:1 ratio as the military service and government employment offset the decline. However, this trend was not experienced by women graduates who reported an employer distribution that reflects a four percentage-point increase in industrial manufacturing positions.

The very small increase (< 2%) in median starting salary for physics bachelors can be attributed in part to the redistribution of employers. Almost all the salaries presented in **Table IX** reflect moderate increases over those paid in the previous year, but an overall shift occurred from industry, the employer that offers the highest salary, to

civilian government, the employer who reduced its median salary. Women's salaries continue to be higher than those offered to men, particularly in industry and the government.

There is general agreement that physics bachelors are well prepared to teach physics at the secondary school level, but the comparatively low salaries offered for those positions attract at most 5% of a graduating class.

The tables that deal with initial employment and starting salaries exclude the group of 141 bachelors described in **Figure II** as "continuing civilian employment." This group did not seek employment in 1989 because its members had decided to remain with employers for whom they worked before receiving their bachelor's degrees. However, those 141 graduates all hold full-time potentially permanent positions whose work activities and types of employers are comparable to those of the newly-employed bachelors. **Table X** relates eight work activities to the five major types of employers and indicates that the physics bachelors who are employed in a service industry are least likely to make extensive use of their training.

Table IX. Starting salaries of physics bachelors, class of 1989.

Type of employer	Men (500 reported salaries)		Women (98 reported salaries)		Total (598 reported salaries)	
	Dist. by employer	Median monthly salary	Dist. by employer	Median monthly salary	Dist. by employer	Median monthly salary
Industry { manufacture	24%	\$2400	32%	\$2475	25%	\$2410
{ service	23	2080	29	2225	24	2090
High school	5	1600	7	1550	5	1570
College or university	5	1400	3	**	5	1450
Government { civilian	9	2000	13	2120	10	2010
{ military	31	1700	9	1400	27	1680
Fed. Fund. Res. Ctr.	1	**	4	**	2	**
Nonprofit organization	2	**	3	**	2	1650
Total	100%	\$1925	100%	\$2180	100%	\$1960

**Insufficient data.

Table X. Full-time employment* of new physics bachelors, class of 1989.

Work activity		Type of employer							Total N %		
		Industry		High school	Government		Coll. univ.	Nonprf. org.			
		manufacture	service		civilian	military					
Teaching		-	2	39	6	-	2	1	50	6%	
Research & development		64	18	-	38	14	24	3	161	19	
Development & design		68	36	-	20	11	4	1	140	17	
Programming		21	43	-	14	5	10	-	93	11	
Technician		34	66	-	17	9	14	2	142	17	
Specialized training**		4	9	-	3	128	-	-	144	17	
Marketing		18	21	-	-	-	-	1	40	5	
Other professional work		11	31	2	3	12	2	9	70	8	
Total } N		220	226	41	101	179	56	17	840		
} %		26	27	5	12	21	7	2		100%	
Use of physics training		{ Extensive		36%	14%	65%	47%	34%	57%	18%	33%
		{ Little		51	48	32	38	48	28	29	45
		{ None		13	38	3	15	18	15	53	22

*The employment of these 840 graduates includes both newly accepted positions as well as those in which graduates are continuing. Excluded are graduates in temporary and summer employment.

**Training paid for by employer includes pilot navigator training by the military.

ASTRONOMY

For purposes of comparison we arranged the information reported by the astronomy bachelors in a similar format to that used for the physics graduates. From our Enrollments and Degrees survey we know that 55 institutions granted a total of 196 astronomy bachelor's degrees in 1988-89. The postbaccalaureate plans and background characteristics of

these astronomy graduates are summarized in two tables and a flow diagram.

The characteristics outlined in Table XI point to several continuing trends. Astronomy bachelors include a larger proportion of women, fewer foreign students and a much

Table XI. Characteristics of astronomy bachelors, 1988-89.

Characteristics		Postbaccalaureate plans				
		Graduate study		Employment	Undecided	Total %
		Astronomy N	Other N			
Initial interest in physics	{ Before high school	30	9	27	3	48%
	{ High School	20	6	26	2	37
	{ College	6	5	10	-	15
Sex	{ Female	12	6	14	-	21%
	{ Male	44	14	49	5	79
Citizenship	{ U.S.	54	20	60	5	97%
	{ Foreign	2	-	3	-	3
Type of high school physics	{ PSSC*	6	3	2	-	8%
	{ Project physics	-	-	3	1	3
	{ AP physics	9	3	9	-	15
	{ General physics	39	13	41	3	66
	{ None	2	1	8	1	8
Age	{ 21 or younger	2	1	3	-	4%
	{ 22	24	11	17	3	38
	{ 23	16	7	14	-	26
	{ 24	7	-	9	-	11
	{ 25 or older	7	1	20	2	21
Type of bachelor's institution	{ PhD-granting	42	13	48	4	74%
	{ MS-granting	2	2	2	-	4
	{ BS/BA-granting	12	5	13	1	22
	{ Public	39	12	44	4	69%
	{ Private	17	8	19	1	31
Total respondents		56	20	63	5	144
Total number of astronomy bachelors		76	27	86	7	196

*PSSC = Physical Science Study Committee.

Table XII. Postbaccalaureate plans of successive graduating classes of astronomy bachelors, 1979-1989.

Postbaccalaureate plans	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89
Astronomy graduate study	35%	24%	29%	38%	38%	35%	40%	51%	34%	39%
Other graduate study	17	13	25	17	31	16	16	14	20	14
Employment	43	59	45	41	28	44	38	34	45	44
Undecided	5	4	1	4	3	3	6	1	1	3
Total number of astronomy bachelors	165	156	181	138	137	145	169	172	181	196

smaller proportion of graduates from four-year colleges. Treating astronomy as a subfield of physics, we learned that almost half of the astronomy degree recipients developed an interest in their discipline well before entering high school; only one-fifth of the physics bachelors did so.

In interpreting the ten-year trend of postbaccalaureate plans presented in **Table XII**, it should be noted that "other graduate study" for astronomy bachelors primarily refers to physics. A listing of those subjects of study identified by the

class of 1989 is included in **Figure III**. The flow diagram also elaborates on the sources of support for the bachelors who entered graduate study in astronomy and shows that 7 out of 63 graduates encountered difficulties in finding suitable employment. During the previous summer 9 out of 45 employment-oriented bachelors identified themselves as unsuccessful job seekers. The military service attracted a smaller proportion of graduates from the class of 1989 than in previous years.

Figure III. Postbaccalaureate plans of astronomy bachelors of the class of 1989.

